SHORT RANGE

ELLA-W1 series

IEEE 802.11a/b/g/n Wi-Fi, Bluetooth 3.0+HS Modules

Data Sheet

Advance Information

Abstract

This technical data sheet describes the ELLA-W1 series Wi-Fi and Bluetooth multiradio modules, which are designed for both simultaneous and independent operation of Wi-Fi 802.11n and Bluetooth 3.0+HS (High Speed). These host-based modules include an integrated MAC/Baseband processor and RF front-end components. They can connect to a host processor through an SDIO interface.

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Objective Specification	Document contains target values. Revised and supplementary data will be published later.
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Production Information	Document contains the final product specification.

This document applies to the following products:

Product name	Type number	Firmware version	PCN / IN reference
ELLA-W131	ELLA-W131-00B-00	-	N/A
ELLA-W131-A	ELLA-W131-00A-00	-	N/A
ELLA-W133	ELLA-W133-00B-00	-	N/A
ELLA-W133-A	ELLA-W133-00A-00	-	N/A
ELLA-W161	ELLA-W161-00B-00	-	N/A
ELLA-W161-A	ELLA-W161-00A-00	-	N/A
ELLA-W163	ELLA-W163-00B-00	-	N/A
ELLA-W163-A	ELLA-W163-00A-00	-	N/A

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1 Functional description

1.1 Overview

The ELLA-W1 series is targeted for integration into different OEM products. These modules are designed for both simultaneous and independent operation of the following technologies:

- IEEE 802.11a/b/g/n payload data rates for Wi-Fi
- Bluetooth 3.0+HS (High Speed)
- Bluetooth 2.1+EDR (Enhanced Data Rate)

The ELLA-W1 series provides a complete end-to-end solution for low-power applications. It includes an integrated MAC/Baseband processor and Radio Frequency (RF) front-end components and can connect to a host processor through an SDIO interface. The ELLA modules are offered in four versions (see Ordering codes and Block diagrams). Host drivers for common operating systems such as Linux and Android are available. The modules are radio type approved for Europe (CE), US (FCC) and Canada (IC).

1.2 Applications

- Wi-Fi and Bluetooth networks
- Audio/video devices and accessories
- Access to laptops, mobile phones, and similar consumer devices
- Automotive and industrial networking
- Home/building automation

1.3 Product features

Model	Radio							Interfaces		Power	Connectors	Features				Grade		
	Wi-Fi 2.4 GHz channels 1-13	Wi-Fi 5 GHz channels 36-165	Wi-Fi IEEE 802.11 version	Bluetooth qualification	Bluetooth profiles	Max output power at antenna pin	Antenna type	SDIO	PCM (Bluetooth audio)	Power supply: 1.8 and 3.3 V	Solder pins	Micro Access Point	AES hardware support	RF parameters in OTP memory	MAC addresses in OTP memory	Standard	Professional	Automotive
ELLA-W131	•		b/g/n	v3.0+HS	H	18 dBm	1p	•	•	•	•	•	•	•	•		T	
ELLA-W133	•		b/g/n	v3.0+HS	H	18 dBm	2p	•	•	•	•	•	•	•	•			
ELLA-W161	•	•	a/b/g/n	v3.0+HS	H	18 dBm	1p	•	•	•	•	•	•	•	•			
ELLA-W163	•	•	a/b/g/n	v3.0+HS	H	18 dBm	2p	•	•	•	•	•	•	•	•			

H = HCI

1p = One pin for combined external antenna for Bluetooth and Wi-Fi

2p = Two pins for separate external antennas for Bluetooth and Wi-Fi

T = Can be combined with TOBY-L2 cellular modules for router functionality

Table 1: Key features of ELLA-W1 series

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1.4 Block diagrams

The block diagrams of the ELLA-W1 series are provided in this section. These block diagrams are valid for both professional and automotive grade variants.

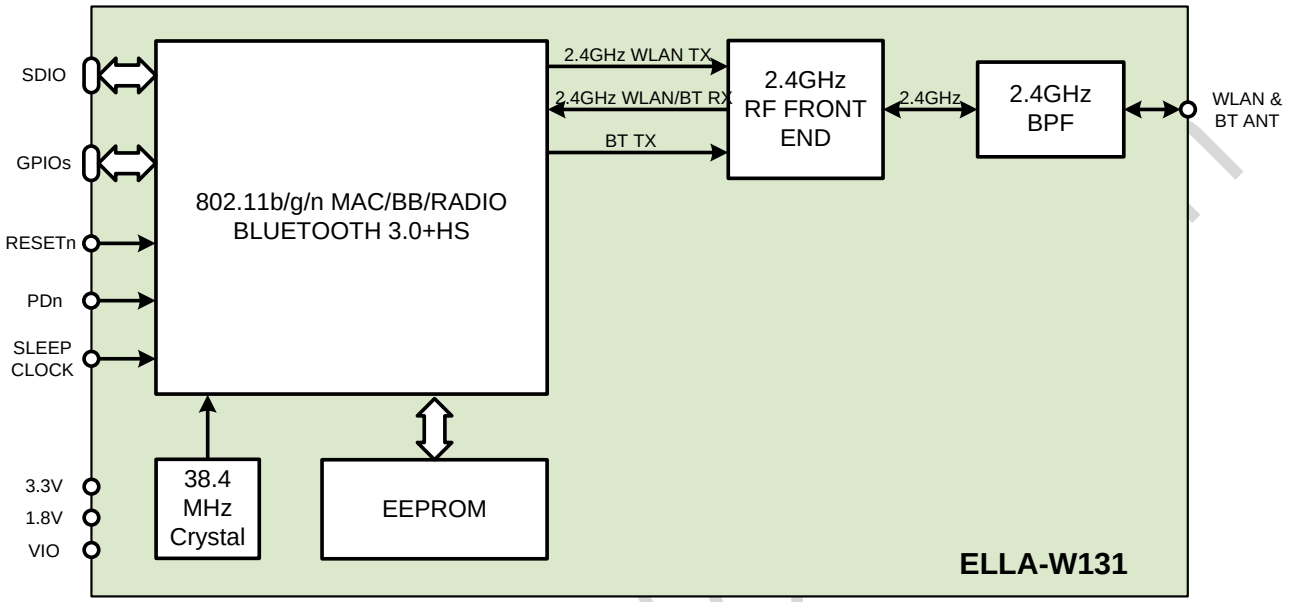

Figure 1: ELLA-W131 block diagram

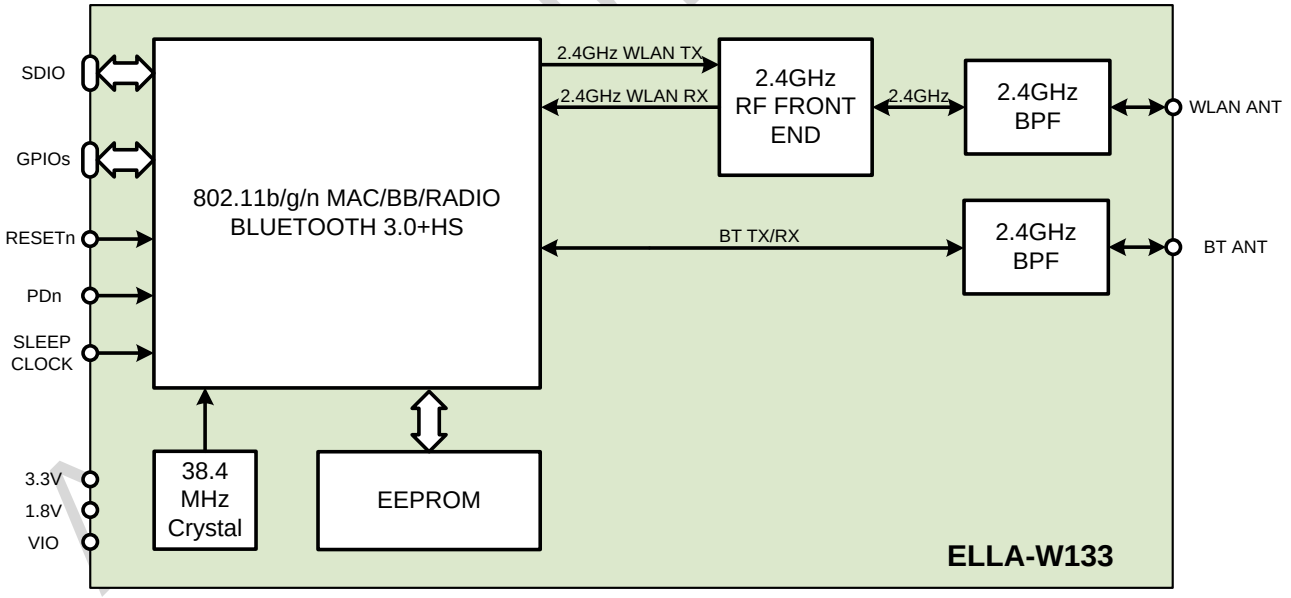

Figure 2: ELLA-W133 block diagram

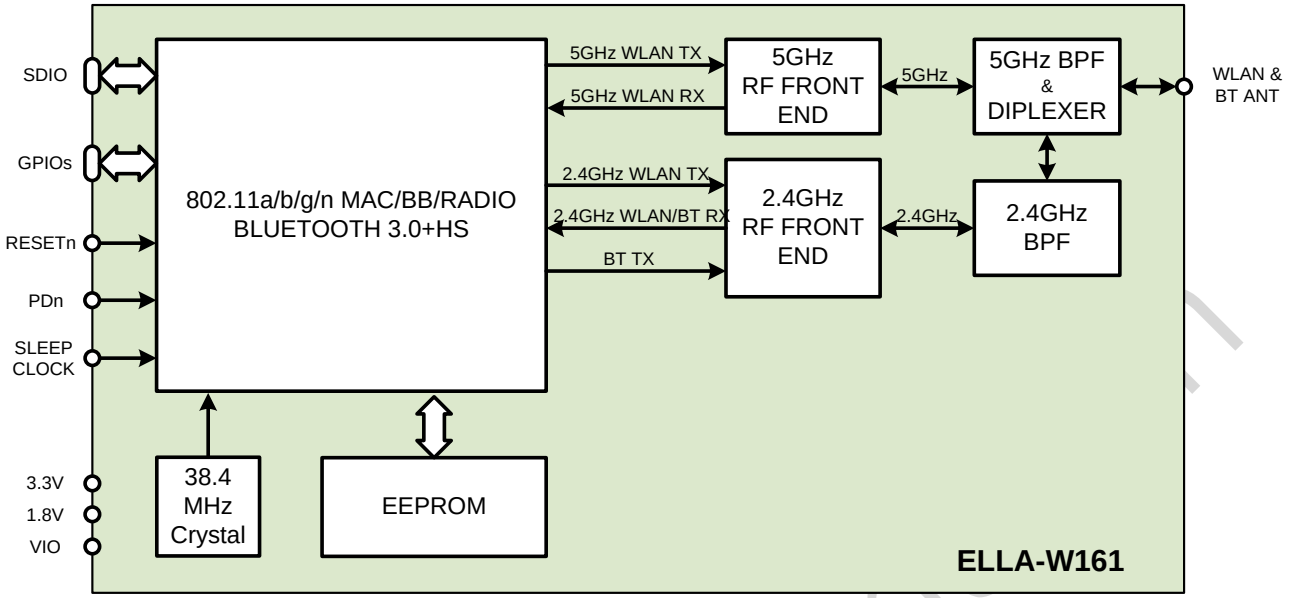

Figure 3: ELLA-W161 block diagram

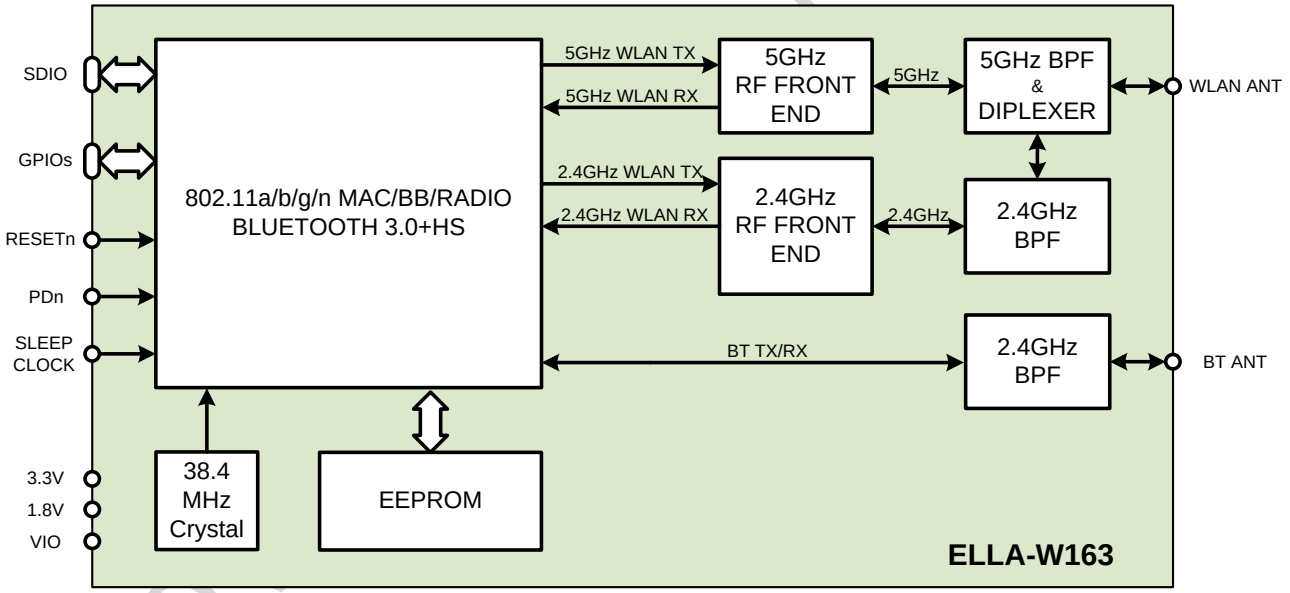

Figure 4: ELLA-W163 block diagram

1.5 Product description

Model	Description
ELLA-W131	Single-band Wi-Fi (IEEE 802.11b/g/n, 2.4 GHz only) and Bluetooth module with one joint antenna connector for Wi-Fi and Bluetooth operation (see block diagram). Recommended for cost effective AP solution, AP with none or rare Bluetooth usage, or cost effective station with one system antenna. The professional grade ELLA-W131 module can be combined with the u-blox TOBY-L2 LTE module for router functionality.
ELLA-W133	Single-band Wi-Fi (IEEE 802.11b/g/n, 2.4 GHz only) and Bluetooth module with separated antenna connectors for Wi-Fi and Bluetooth operation (see block diagram). Overall performance (throughput) is maximized for AP mode with simultaneous Bluetooth traffic. Two system antennas are required (one for Wi-Fi and another for Bluetooth) with 30 dB or better isolation between the antennas (orthogonal oriented antennas with more than 50…60 mm distance between). Recommended for higher performance of the AP.
ELLA-W161	Dual-band Wi-Fi (IEEE 802.11a/b/g/n, 2.4 and 5 GHz) and Bluetooth module with one joint antenna connector for Wi-Fi and Bluetooth operation (see block diagram). Same as ELLA-W131 but with dual-band support.
ELLA-W163	Dual-band Wi-Fi (IEEE 802.11a/b/g/n, 2.4 and 5 GHz) and Bluetooth module with separated antenna connectors for Wi-Fi and Bluetooth operation (see block diagram). Same as ELLA-W133 but with dual-band support.

☞ For maximum throughput during simultaneous Wi-Fi (AP) and Bluetooth operation, the Bluetooth Coexistence Arbiter (BCA) settings should be optimized by the host system software.

1.6 Supported features

- Standards: IEEE 802.11a/b/g/n/e/i/h/d/k[1]/r[1]/w
- Wi-Fi 802.11a/b/g/n station and micro access point operation (up to 10 associated clients supported)
- Four MAC-addresses reserved per module
- Support of Wi-Fi Direct mode
- 802.11 PHY data rates up to 72 Mbps (20 MHz channel) and up to 150 Mbps (40 MHz channel)
- Hardware encryption engine for 128-bit AES (AES-CCMP for WPA2, AES-CMAC)
- WEP 64- and 128-bit encryption with hardware TKIP processing (WPA)
- Embedded security supplicant
- WAPI support
- Background scan mode
- Bluetooth v3.0+HS (High Speed)
- Bluetooth v2.1+EDR (backward compatibility)
- Wide temperature operation range -40°C to +85°C
- Compact 14.8mm x 14.8mm footprint, surface mounting
- SDIO high-speed interface
- Support for low-power modes
- CE/FCC/IC radio type approved
- RoHS compliant
- Automotive qualification tests (climatic, mechanical, and operating life tests) according to VW 80000 / ISO 16750-4

1.7 Additional reserved MAC addresses

The ELLA-W1 series has four unique consecutive MAC addresses reserved for each module, from which the first two addresses have already been stored in the configuration inside the EEPROM during the production. The first address is used for the Bluetooth communication and the second address is configured for the usage with the Wi-Fi communication. The remaining two MAC addresses are not used in the manufacturing configuration, but are reserved for the usage with the module.

[1] Supported by hardware but not supported by the Marvell software currently.

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MAC address	Assignment	Last two bits of MAC address	Example
Module1, address 1	Bluetooth	0b00	D4:CA:6E:44:00:04
Module1, address 2	Wi-Fi	0b01	D4:CA:6E:44:00:05
Module1, address 3	(free for use)	0b10	D4:CA:6E:44:00:06
Module1, address 4	(free for use)	0b11	D4:CA:6E:44:00:07
Module2, address 1	Bluetooth	0b00	D4:CA:6E:44:00:08
Module2, address 2	Wi-Fi	0b01	D4:CA:6E:44:00:09
Module2, address 3	(free for use)	0b10	D4:CA:6E:44:00:0A
Module2, address 4	(free for use)	0b11	D4:CA:6E:44:00:0B

Table 2: MAC address assignment

Advance Information

2 Host interfaces

2.1 SDIO interface

ELLA-W1 series modules support an SDIO device interface that conforms to the industry standard SDIO Full-Speed specification and allows a host controller using the SDIO bus protocol to access the Wi-Fi and Bluetooth functions. The modules also support High-Speed mode as defined in the SDIO 1.2 specification.

The module's SDIO host interface pins are powered from the VIO voltage supply. A module acts as the device on the SDIO bus. The SDIO interface supports SDIO modes at the full clock range of 0 to 50 MHz which allows a maximum throughput of 200 Mbps.

See the *ELLA-W1 System Integration Manual [2]* for information about SDIO timing.

Advance Information

3 Pin definition

3.1 Pin description

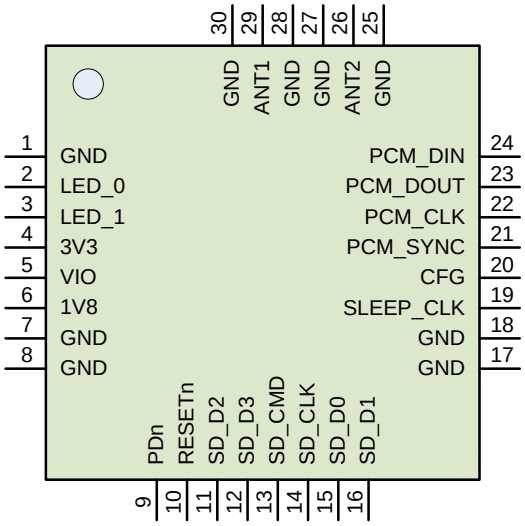

Figure 5: Pin assignment

No	Name	Pin Type	Description
1	GND	Ground	Ground
2	LED_0	I/O	LED output (GPIO_1 of Radio/Baseband processor), Wi-Fi activity[2]
3	LED_1	I/O	LED output (GPIO_17 of Radio/Baseband processor), Bluetooth activity[2]
4	3V3	Power	3.3V Power supply (3.0V...3.6V)
5	VIO	Power	VIO Supply (1.8V or 3.3V)
6	1V8	Power	1.8V Supply (1.7V...1.9V)
7	GND	Ground	Ground
8	GND	Ground	Ground
9	PDn	I	Full power down (active low), has internal pull-up to VIO pin
10	RESETn	I	Reset (active low), has weak internal pull-up to VIO pin
11	SD_D2	I/O	SDIO Data line bit [2]
12	SD_D3	I/O	SDIO Data line bit [3]
13	SD_CMD	I/O	SDIO Command
14	SD_CLK	I	SDIO Clock input
15	SD_D0	I/O	SDIO Data line bit [0]
16	SD_D1	I/O	SDIO Data line bit [1]
17	GND	Ground	Ground
18	GND	Ground	Ground
19	SLEEP_CLK	I	Clock input for external sleep clock source (32.768 kHz)[3]

[2] Possible to use as a LED output depending on firmware (driver) version. Regardless of the I/O supply (1.8V or 3.3V), the supply to the actual board LED always needs to use 3.3V on the other end of the LED and works as open drain circuitry in that case. LED current limiting resistor should be used. Maximum sink to the ground current - 10 mA.

[3] Needed during power save operation. Not required for full power mode and for automotive use (firmware and driver version 14.44). Mandatory for all other releases with sleep mode support. Sleep clock signal requirements: frequency 32.768 kHz ±250ppm, low level from 0 to 0.25V, high level from 0.8 to 2.0V, duty cycle 20-80%, slew rate less than 100nS (10-90%).

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No	Name	Pin Type	Description
20	CFG	I/O	Configuration pin[4]
21	PCM_SYNC	I/O	GPIO_14 of Radio/Baseband processor, output if master, input if slave
22	PCM_CLK	I/O	GPIO_13 of Radio/Baseband processor, output if master, input if slave
23	PCM_DOUT	O	GPIO_12 of Radio/Baseband processor, output
24	PCM_DIN	I	GPIO_11 of Radio/Baseband processor, input
25	GND	Ground	Ground
26	ANT2	I/O, RF	Bluetooth antenna for ELLA-W133/W163 module, at ELLA-W131/W161 not connected
27	GND	Ground	Ground
28	GND	Ground	Ground
29	ANT1	I/O, RF	Wi-Fi + Bluetooth antenna for ELLA-W131/W161 module, Wi-Fi only antenna for ELLA-W133/W163 module
30	GND	Ground	Ground

Table 3: ELLA-W1 series pin description

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[4] Leave it unconnected when 32.768 kHz Sleep Clock provided, pull down by 47K resistor for Sleep Clock less operation.

4 Electrical specification

Stressing the device above one or more of the ratings listed in the Absolute Maximum Rating section may cause permanent damage. These are stress ratings only. Operating the module at these or at any conditions other than those specified in the Operating conditions section of this document should be avoided. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Operating condition ranges define those limits within which the functionality of the device is guaranteed. Where application information is given, it is advisory only and does not form part of the specification.

4.1 Absolute maximum ratings

Symbol	Description	Min.	Max.	Units
3V3	Power supply voltage 3.3V	-0.3	3.6	V
1V8	Power supply voltage 1.8V	-0.3	2.0	V
VIO	I/O supply voltage 1.8V/3.3V	-0.3	3.6	V
$T_{STORAGE}$	Storage temperature	-40	+85	°C

Table 4: Absolute maximum ratings

The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection devices.

4.2 Operating conditions

Symbol	Parameter	Min.	Typ	Max.	Units
3V3	Power supply voltage 3.3V	3.1	3.3	3.6	V
1V8	Power supply voltage 1.8V	1.74	1.8	1.89	V
VIO	I/O supply voltage 1.8V/3.3V	1.62	1.8	1.98	V
		3.0	3.3	3.6	V
T_A	Ambient operating temperature	-40	-	+85	°C
Ripple Noise	Peak-to-peak voltage ripple on 3V3 and 1V8 supply lines.	-	-	10	mV

Table 5: Operating conditions

4.3 Digital pad ratings

Symbol	Parameter	Mode[5]	Min.	Max.	Units
V_{IH}	Input high voltage	1.8V	0.8*1V8	1V8+0.3	V
		3.3V	0.7*3V3	3V3+0.3	V
V_{IL}	Input low voltage	1.8V	-0.3	0.3*1V8	V
		3.3V	-0.3	0.3*3V3	V
V_{HYS}	Input hysteresis	1.8V	150	-	mV
		3.3V	200	-	mV
V_{OH}	Output high voltage	1.8V	1V8-0.4	-	V
		3.3V	3V3-0.4	-	V
V_{OH}	Output low voltage	1.8V	-	0.4	V
		3.3V	-	0.4	V

Table 6: Digital pad ratings

[5] IO voltage, see Table 6 for possible IO voltage range.

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4.4 Peak current consumption

Operation Mode			Peak current[6] (mA)		
			1.8V	VIO[7]	3.3V
RX	2.4 GHz		160	10	0.1
	5 GHz		170	10	14
TX	2.4 GHz	+18 dBm	140	10	200
		+15 dBm	140	10	170
		+12 dBm	140	10	145
		+6 dBm	140	10	120
	5 GHz	+15 dBm	150	10	200
		+12 dBm	150	10	170
		+6 dBm	150	10	150

Table 7: Peak current consumption

4.5 Wi-Fi power consumption

Operation Mode: 2.4 GHz Wi-Fi client mode, Bluetooth in deep sleep	Average current (mA)		
	VIO (1.8V)	3.3V	1.8V
RX 11b 11 Mb/s	0.43	0.08	125
RX 11g 54 Mb/s	0.88	0.08	133
RX 11n 72 Mb/s	1.1	0.08	138
RX 11n 72 Mb/s, A-MPDU on	1.9	0.08	146
TX 11b 11 Mb/s 10 dBm	0.1	94	112
TX 11b 11 Mb/s 12 dBm	0.1	101	114
TX 11b 11 Mb/s 15 dBm	0.1	116	114
TX 11b 11 Mb/s 18 dBm	0.1	134	114
TX 11g 54 Mb/s 10 dBm	0.11	95	124
TX 11g 54 Mb/s 12 dBm	0.11	100	124
TX 11g 54 Mb/s 15 dBm	0.11	110	124
TX 11n 72 Mb/s 10 dBm	0.1	94	124
TX 11n 72 Mb/s 12 dBm	0.1	98	124
TX 11n 72 Mb/s 15 dBm	0.1	110	124
TX 11n 72 Mb/s 10 dBm, A-MPDU on	0.05	92	130
TX 11n 72 Mb/s 12 dBm, A-MPDU on	0.05	97	130
TX 11n 72 Mb/s 15 dBm, A-MPDU on	0.05	118	132

Table 8: Current consumption in 2.4 GHz Wi-Fi client mode

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[6] Peak values are shown. The average current for full operation mode (not a power save mode) strongly depends on RX/TX time ratio and remains within the range between the peak values of RX and TX.
[7] VIO current is shown for 3.3V I/O voltage.

Operation Mode: 5 GHz Wi-Fi client mode, Bluetooth in deep sleep	Average current (mA)		
	VIO (1.8V)	3.3V	1.8V
RX 11a 54 Mb/s	1.1	14	151
RX 11n (HT20) 72 Mb/s	1.0	14	153
RX 11n (HT20) 72 Mb/s, A-MPDU on	1.4	14	160
TX 11a 54 Mb/s 10 dBm	0.11	120	135
TX 11a 54 Mb/s 12 dBm	0.11	128	135
TX 11a 54 Mb/s 15 dBm	0.11	146	138
TX 11n (HT20) 72 Mb/s 10 dBm	0.11	122	134
TX 11n (HT20) 72 Mb/s 12 dBm	0.11	127	135
TX 11n (HT20) 72 Mb/s 15 dBm	0.11	144	140
TX 11n (HT20) 72 Mb/s 10 dBm, A-MPDU on	0.1	116	142
TX 11n (HT20) 72 Mb/s 12 dBm, A-MPDU on	0.1	120	142
TX 11n (HT20) 72 Mb/s 15 dBm, A-MPDU on	0.1	139	142

Table 9: Current consumption in 5 GHz Wi-Fi client mode

Operation Mode: 2.4 GHz IEEE Power Save, Bluetooth in deep sleep	Average current (mA)		
	VIO (1.8V)	3.3V	1.8V
Wi-Fi in deep sleep	0.006	0.012	0.032
Wi-Fi DTIM 1	0.006	0.012	1.175
Wi-Fi DTIM 3	0.006	0.012	0.413

Table 10: Current consumption in 2.4 GHz Wi-Fi IEEE power save

Operation Mode: 2.4 GHz AP mode, 802.11b/g/n, 20 MHz, long guard interval, A-MPDU on		Average current (mA)		
		VIO (1.8V)	3.3V	1.8V
No power save	Idle	0.06	0.08	134
	Active, Open, RX	2.12	0.08	150
	Active, Open, TX	0.013	102	134
	Active, WPA2, RX	1.98	0.08	158
	Active, WPA2, TX	0.017	97	139
Inactivity based power saving Beacon period = 100 ms DTIM = 1 Sleep period = 17 ms Inactivity timeout = 200 ms Awake period = 2 ms NULL data protection = enabled	Idle	0.08	0.08	25
	Active, Open, RX	2.11	12.5	151
	Active, Open, TX	0.02	102	134
	Active, WPA2, RX	1.9	0.08	158
	Active, WPA2, TX	0.012	104	139

Table 11: Current consumption in 2.4 GHz Wi-Fi AP mode

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Operation Mode: 5 GHz AP mode, 802.11a/n, 20 MHz, long guard interval, A-MPDU on		Average current (mA)		
		VIO (1.8V)	3.3V	1.8V
No power save	Idle	0.056	12	139
	Active, Open, RX	1.98	14	160
	Active, Open, TX	0.02	128	149
	Active, WPA2, RX	2.0	14	170
	Active, WPA2, TX	0.02	128	161
Inactivity based power saving Beacon period = 100 ms DTIM = 1 Sleep period = 17 ms Inactivity timeout = 200 ms Awake period = 2 ms NULL data protection = enabled	Idle	0.09	2	24
	Active, Open, RX	1.98	14	164
	Active, Open, TX	0.02	124	151
	Active, WPA2, RX	2.03	14	173
	Active, WPA2, TX	0.02	128	163

Table 12: Current consumption in 5 GHz Wi-Fi AP mode

4.6 Bluetooth power consumption

Operation Mode: Bluetooth, Wi-Fi in deep sleep	Current (mA)		
	VIO (1.8V)	3.3V	1.8V
Page scan at 1.28 s	0.006	0.015	0.267
Inquiry scan at 1.28 s	0.006	0.015	0.267
Page & Inquiry scan at 1.28 s	0.006	0.015	0.498
HV3 SCO mode ACL sniff 0x800	0.41	0.08	11.5
eSCO mode EV3 ACL sniff 0x800	0.41	0.08	11.7
Chip deep sleep	0.06	0.015	0.035
Peak Bluetooth TX 4 dBm	0.006	0.015	30.8
Peak Bluetooth RX	0.006	0.015	28.0
Bluetooth idle (sleep mode)	0.006	0.08	5.06
1.28 s ACL sniff mode	0.012	0.015	0.107
ACL DM1	0.012	0.075	12.6
ACL 2-DH1	0.012	0.015	13.5
ACL 3-DH5	0.012	0.015	14.0
A2DP offload	0.47	0.08	20.4
A2DP, BDR 330 kb/s	0.14	0.08	15.7
A2DP, EDR 330 kb/s	0.14	0.08	13.5

4.7 Radio specifications

4.7.1 Wi-Fi

The ELLA-W1 series modules support dual-band Wi-Fi with 802.11b/g/n operation in the 2.4 GHz radio band. The 802.11a/n operation in the 5 GHz radio band is supported in ELLA-W161 and ELLA-W163 only. The module is designed to operate in only one frequency band at a time.

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Parameter		Operation Mode			Specification
RF Frequency Range		802.11b/g/n			2.400 – 2.500 GHz
		802.11a/n			4.900 – 5.825 GHz
Modulation		802.11b			CCK and DSSS
		802.11a/g/n			OFDM
Supported Data Rates		802.11b			1, 2, 5.5, 11 Mbps
		802.11a/g			6, 9, 12, 18, 24, 36, 48, 54 Mbps
		802.11n			MCS0 - MCS7
Supported Bandwidth		802.11n			20, 40 MHz
Supported Guard Interval		802.11n			400, 800 ns
Maximum Transmit Power		802.11b			18 dBm ± 1 dB
		802.11a/g/n			15 dBm ± 1 dB
Receiver Sensitivity	2.4 GHz	802.11b		1 Mbps	-96 dBm ± 1 dB
				11 Mbps	-87 dBm ± 1 dB
		802.11g		6 Mbps	-89 dBm ± 1 dB
				54 Mbps	-71 dBm ± 1 dB
		802.11n	20 MHz	MCS0	-88 dBm ± 1 dB
				MCS7	-69 dBm ± 1 dB
			40 MHz	MCS0	-85 dBm ± 1 dB
				MCS7	-66 dBm ± 1 dB
	5 GHz	802.11a		6 Mbps	-92 dBm ± 1 dB
				54 Mbps	-75 dBm ± 1 dB
		802.11n	20 MHz	MCS0	-91 dBm ± 1 dB
				MCS7	-72 dBm ± 1 dB
			40 MHz	MCS0	-89 dBm ± 1 dB
				MCS7	-69 dBm ± 1 dB

Table 13: Wi-Fi radio specifications

Channel	Frequency, GHz
1	2.412
2	2.417
3	2.422
4	2.427
5	2.432
6	2.437
7	2.442
8	2.447
9	2.452
10	2.457
11	2.462
12	2.467
13	2.472

Table 14: 2.4 GHz Band supported channels, 20 MHz bandwidth

Channel		Frequency, GHz
1	5	2.422
2	6	2.427
3	7	2.432
4	8	2.437
5	9	2.442
6	10	2.447
7	11	2.452

Table 15: 2.4 GHz Band supported channels, 40 MHz bandwidth

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Channel	Frequency, GHz
36	5.180
40	5.200
44	5.220
48	5.240
52	5.260
56	5.280
60	5.300
64	5.320
100	5.500
104	5.520
108	5.540
112	5.560
116	5.580
120	5.600
124	5.620
128	5.640
132	5.660
136	5.680
140	5.700
149	5.745
153	5.765
157	5.785
161	5.805
165	5.825

Table 16: 5 GHz Band supported channels, 20 MHz bandwidth

Channel		Frequency, GHz
36	40	5.190
44	48	5.230
52	56	5.270
60	64	5.310
100	104	5.510
108	112	5.550
116	120	5.590
124	128	5.630
132	136	5.670
149	153	5.755
157	161	5.795

Table 17: 5 GHz Band supported channels, 40 MHz bandwidth

4.7.2 Bluetooth

Parameter	Specifications
RF Frequency Range	2.400 – 2.4835 GHz
Supported Modes	Bluetooth v2.1+EDR, Bluetooth v3.0+HS
Number of channels	79
Modulation	1 Mbps: GFSK (BDR) 2 Mbps: π/4-DQPSK (EDR) 3 Mbps: 8-DPSK (EDR)
Transmit Power	+8 dBm ± 1.5 dB
Receiver Sensitivity	BDR: -90 dBm ± 1.5 dB EDR: -87 dBm ± 1.5 dB

Table 18: Bluetooth radio specifications

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5 Mechanical specifications

The ELLA-W1 series professional grade modules have an RF shield box while the automotive grade modules do not have the RF shield box.

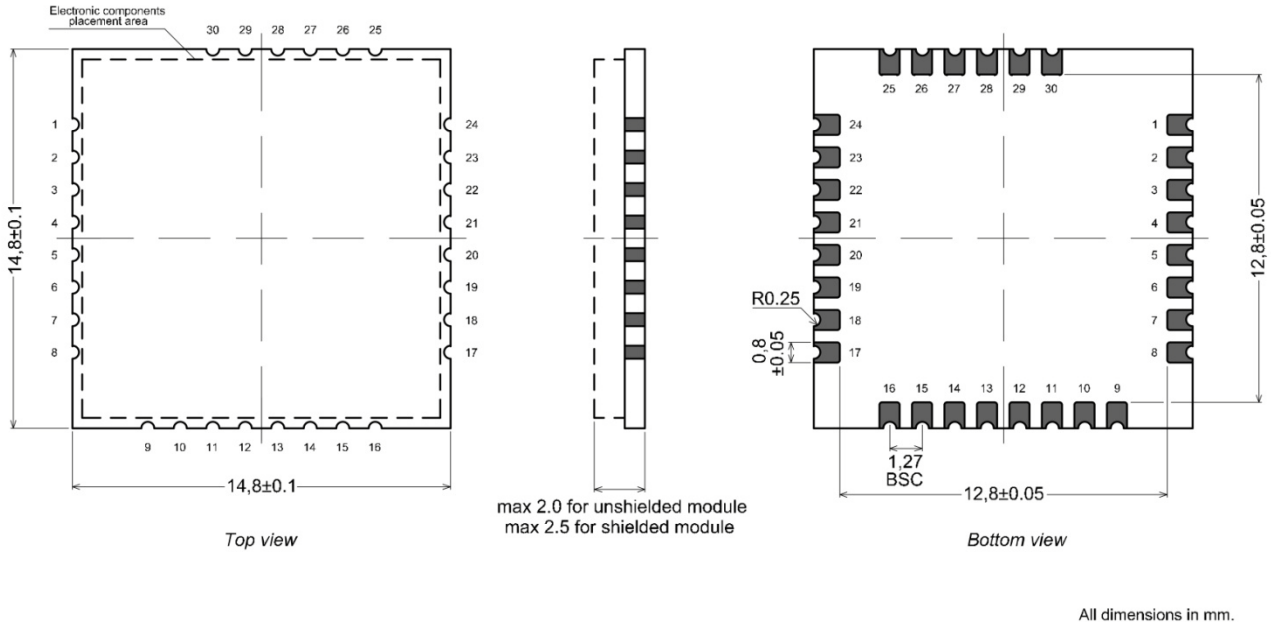

Figure 6: Physical dimensions

The tolerances +/- 0.1 mm may be exceeded in the corners of the PCB due to the cutting process. In worst case, the outer dimensions could reach 15.1 mm.

Advance In.

5.1 Recommended footprint

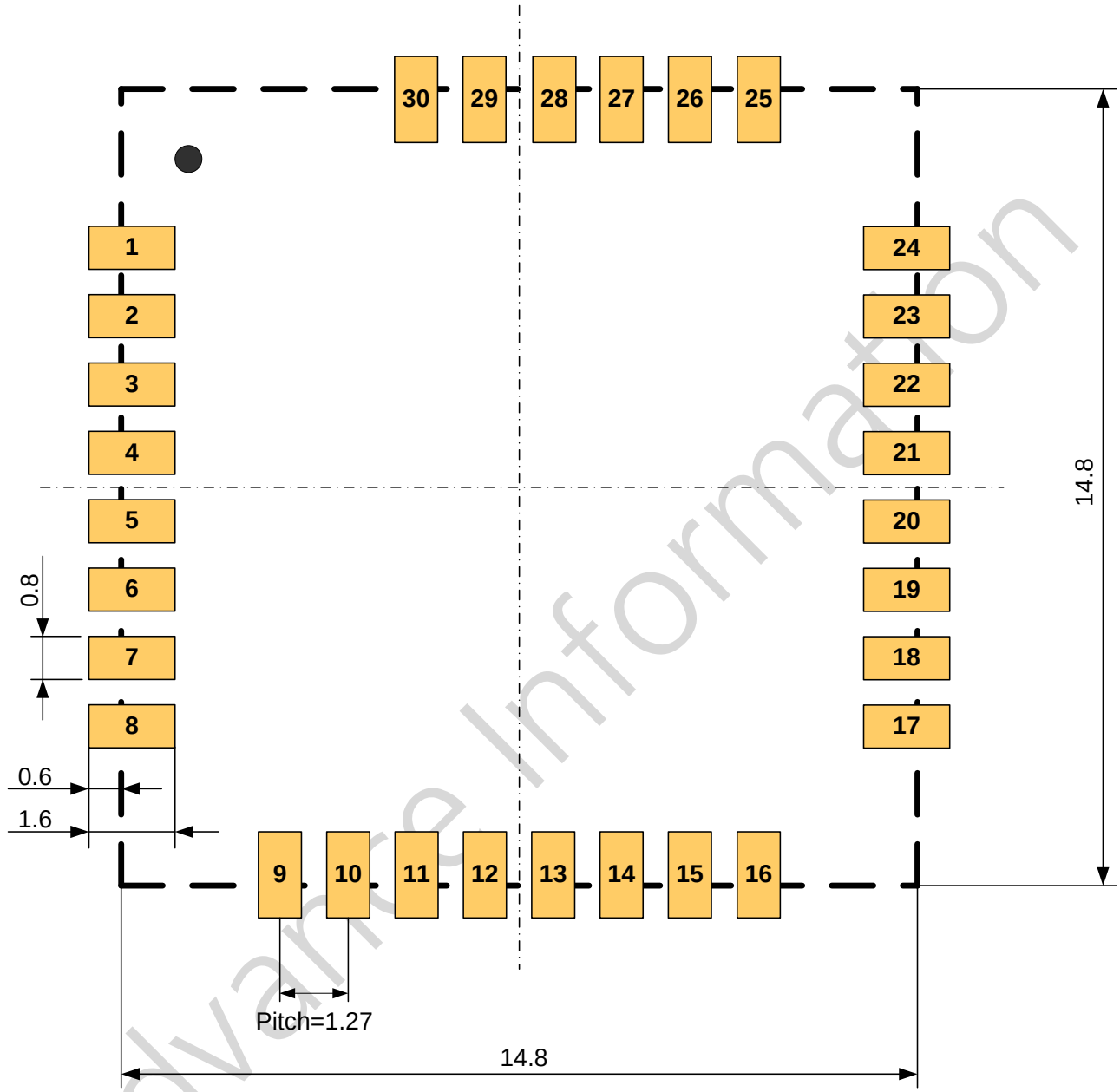

Figure 7: Recommended footprint (dimensions in mm)

Advance Information

6 Qualification and approvals

6.1 Approvals

Products marked with this lead-free symbol on the product label comply with the "Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS).

ELLA-W1 series Wi-Fi modules are RoHS compliant.

6.1.1 European Union regulatory compliance

The ELLA-W1 series modules comply with the following regulatory standards:

Effective use of spectrum:

EN 300 328 V 1.8.1

EN 301 893 V 1.7.1

EMC:

EN 301 489-1/-17

Health and safety:

EN 60950-1:2006 + A11:2009

EN 62311 (WLAN)

EN 62479 (BT)

We declare that the human exposure of these modules is below the SAR limits specified in the EU recommendations 1999/519/EC.

6.1.1.1 Equipment classes

A multi-radio module is classified as class-1 or class-2 radio equipment depending on the frequency band in which it can operate. This equipment class is inherited by the end-product that integrates the module, thus it must be marked accordingly.

Class-1 radio equipment can be placed on the market and put into service without restrictions. (Article 1 of Commission Decision 2000/299/EC of April 6 2000)

This multi-radio module is defined as class-1 radio equipment when it is restricted to operate in the following frequency bands:

- Bluetooth, ISM band 2400 – 2483.5 MHz
- WLAN, ISM band 2400 – 2483.5 MHz
- WLAN, U-NII band-2e 5470 – 5725 MHz

Class-2 radio equipment includes restrictions applied by Member States as indicated in Article 1(2) of the Commission Decision. This class uses the "Alert Sign" as an equipment class identifier.

Figure 8: **Alert sign to identify equipment Class-2**

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If an end product allows the multiradio module to operate in the 5150-5350 MHz band (WLAN channel: 36-64), it is defined as class-2 radio equipment and must be marked accordingly. Class-2 radio equipment must have the "alert" sign affixed on the equipment, packaging and printed in the user manual.

The ELLA-W1 multiradio module uses harmonized frequency bands, thus it is comprised by subclass H01 of class-2 equipment, for which notification in accordance with article 6(4) of the R&TTE directive is not necessary.

A definition of subclasses of Class 2 equipment can be found in the following link:

http://ec.europa.eu/enterprise/sectors/rtte/files/rtte-subclass2_en.pdf.

The table below shows the restrictions when operating WLAN at different bands within the European countries

Band	Channel number	Channel frequency [MHZ]	Indoor use allowed	Outdoor use allowed	Radio Equipment Class
ISM	1 – 13	2412 – 2472	Yes	Yes	1
U-NII 1	36 – 48	5180 – 5240	Yes	No	2
U-NII 2	52 – 64	5260 – 5320	Yes	No	2
U-NII 2e	100 – 140	5500 – 5700	Yes	Yes	1

Table 19: **Operating restrictions and radio equipment classification of ELLA-W1 series**

Guidance on how the end product is marked in accordance with the R&TTE directive is found in the following links:

http://ec.europa.eu/enterprise/sectors/rtte/documents/index_en.htm#h2-5
http://ec.europa.eu/enterprise/sectors/rtte/documents/guidance/index_en.htm

A direct link to the quick guide to the marking requirements can be found here:
http://ec.europa.eu/enterprise/sectors/rtte/files/guidance/guidance_en.pdf

IMPORTANT: The "CE" marking must be affixed to a visible location on the OEM product in which this module is installed and has to be labeled in accordance to R&TTE Directive 1999/5/EC.

6.1.2 FCC compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by u-blox could void the user's authority to operate the equipment. The internal / external antenna(s) used for this module must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

In accordance with 47 CFR § 15.19, the end product into which this module is integrated shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

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When the end-product is so small or for such use that it is not practical to place the above statement on it, the information shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or on the container in which the device is marketed. However, the FCC ID label must be displayed on the device.

If the end-product will be installed in locations where the end-user is not able to see the FCC ID and/or this statement, the FCC ID and the statement shall also be included in the end-product manual.

☞ The outside of final products containing the ELLA-W1 module must display in a user accessible area a label referring to the enclosed module. This exterior label can use wording such as the following[8]: "Contains Transmitter Module FCC ID: PV7-WIBEAR11N-SF1" or "Contains FCC ID: PV7-WIBEAR11N-SF1".

☞ The approval type for the ELLA-W1 series variants is a limited modular approval due to the absence of a shielding. This requires any manufacturer of original equipment containing the ELLA-W1 modules to ask for an approval of their design by the manufacturer of the ELLA-W1 modules (u-blox).

6.1.3 IC compliance

This ELLA-W1 series module complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

☞ Any notification to the end user of installation or removal instructions about the integrated radio module is NOT allowed. Unauthorized modification could void authority to use this equipment.

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

This radio transmitter IC: 7738A-WB11NSF1, 7738A-WB11NSF2, 7738A-WB11NDF1, 7738A-WB11NDF2 has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

☞ for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;

☞ Operation in the 5600-5650 MHz band is not allowed in Canada. High-power radars are allocated as primary users (i.e. priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and that these radars could cause interference and/or damage to LE-LAN devices.

The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device; otherwise, the host device must be labeled to display the Industry Canada certification number for the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows: Contains transmitter module IC: 7738A-WB11NSF1 / 7738A-WB11NSF2 / 7738A-WB11NDF1 / 7738A-WB11NDF2

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet équipement est conforme aux limites d'exposition de rayonnement d'IC RSS-102 déterminées pour un environnement non contrôlé. Cet équipement devrait être installé et actionné avec la distance minimum 20 cm entre le radiateur et votre corps.

[8] FCC and IC IDs for the ELLA-W1 module variants are shown in Table 21. Select the applicable ID.

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Cet émetteur radio IC: 7738A-WB11NSF1, 7738A-WB11NSF2, 7738A-WB11NDF1, 7738A-WB11NDF2 été approuvé par Industry Canada pour fonctionner avec les types d'antenne énumérés ci-dessous avec le gain maximum autorisé et l'impédance nécessaire pour chaque type d'antenne indiqué. Les types d'antenne ne figurant pas dans cette liste et ayant un gain supérieur au gain maximum indiqué pour ce type-là sont strictement interdits d'utilisation avec cet appareil.

☞ Le dispositif de fonctionnement dans la bande 5150-5250 MHz est réservé à une utilisation en intérieur pour réduire le risque d'interférences nuisibles à la co-canal systèmes mobiles par satellite

☞ Opération dans la bande 5600-5650 MHz n'est pas autorisée au Canada. Haute puissance radars sont désignés comme utilisateurs principaux (c.-àutilisateurs prioritaires) des bandes 5250-5350 MHz et 5650-5850 MHz et que ces radars pourraient causer des interférences et / ou des dommages à dispositifs LAN-EL.

L'étiquette d'homologation d'Industrie Canada d'un module donné doit être posée sur l'appareil hôte à un endroit bien en vue en tout temps. En l'absence d'étiquette, l'appareil hôte doit porter une étiquette sur laquelle figure le numéro d'homologation du module d'Industrie Canada, précédé des mots « Contient un module d'émission », ou du mot « Contient », ou d'une formulation similaire allant dans le même sens et qui va comme suit : Contient le module d'émission IC: 7738A-WB11NSF1 / 7738A-WB11NSF2 / 7738A-WB11NDF1 / 7738A-WB11NDF2

The internal / external antenna(s) used for this module must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

☞ The approval type for all the ELLA-W1 series variants is a limited modular approval. Due to Industry Canada Modular Approval Requirements (Source: RSP-100 Issue 10), any application which includes the ELLA-W1 series module must be approved by the module manufacturer (u-blox). The application manufacturer must provide design data for the review procedure.

6.1.4 Approved antennas list

For Bluetooth and Wi-Fi operation in the 2.4 GHz band, the module has been tested and approved for use with the antennas listed in Table 20.

Model name	Manufacturer and description	Gain [dBi] (peak)	ELLA-W1 Models			
			W131	W133	W161	W163
2450AT45A100	Johanson Technology, chip antenna, 2.4 – 2.5 GHz	3.0	✓	✓	✓	✓
ANT-2.4-CW-RCT-RP	Linx, dipole antenna, 2.390 – 2.510 GHz	2.2			✓	

Table 20: Approved antennas list, single-band operation

For Bluetooth and Wi-Fi operation in the 2.4 GHz band and Wi-Fi operation in the 5 GHz band, the module has been tested and approved for use with the antennas listed in the table below.

Model name	Manufacturer and description	Gain [dBi] (peak)	ELLA-W1 Models			
			W131	W133	W161	W163
A10194	Antenova, dual-band SMD antenna, 2.4 – 2.5 GHz and 4.9 – 5.9 GHz	1.8 @ 2.4 GHz band 4.1 @ 5 GHz band			✓	✓[9]
ANT-DB1-RAF-RPS	Linx, dual-band dipole antenna, 2.400 – 2.483 GHz and 5.150 – 5.825 GHz	2.675 @ 2.4 GHz band 4.599 @ 5 GHz band			✓	
GW.40.2153	Taoglas, dual-band dipole antenna, 2.4 – 2.5 GHz and 5.150 – 5.850 GHz	3.74 @ 2.4 GHz band 2.5 @ 5 GHz band			✓	
GW.59.3153	Taoglas, dual-band dipole antenna, 2.4 – 2.5 GHz and 5.150 – 5.850 GHz	2.37 @ 2.4 GHz band 2.93 @ 5 GHz band			✓	

Table 21: Approved antennas list, dual-band operation

[9] Tested and approved for Bluetooth and Wi-Fi operation in the 2.4 GHz band and Wi-Fi operation in the 5 GHz band on antenna pad 1.

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The module may be integrated with other antennas which the OEM installer must authorize with respective regulatory agencies and after approval of the module manufacturer.

6.1.5 FCC and IC IDs

Model[10]	FCC ID	IC ID
ELLA-W131	PV7-WIBEAR11N-SF1	7738A-WB11NSF1
ELLA-W133	PV7-WIBEAR11N-SF2	7738A-WB11NSF2
ELLA-W161	PV7-WIBEAR11N-DF1	7738A-WB11NDF1
ELLA-W163	PV7-WIBEAR11N-DF2	7738A-WB11NDF2

Table 22: FCC and IC IDs for different models of ELLA-W1 series

6.1.6 Bluetooth qualification

The ELLA-W1 series is listed at the Bluetooth SIG (https://www.bluetooth.org/en-us) under QD ID 54755. The Product Type is "Controller Subsystem". Specification Name is "3.0+HS".

All four module variants are listed as product variants under the above mentioned QD ID.

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[10] The FCC and IC IDs are the same for professional and automotive grade variants of each ELLA-W1 model.

7 Product handling

7.1 Packaging

The ELLA-W1 series modules are delivered as hermetically sealed, reeled tapes to enable efficient production, production lot set-up and tear-down. For more information about packaging, see the *u-blox Package Information Guide [1]*.

7.1.1 Reels

The ELLA-W1 series modules are deliverable in quantities of 500 pieces on a reel. The ELLA-W1 series modules are shipped on reel Type A as specified in the *u-blox Package Information Guide [1]*.

7.1.2 Tapes

Figure 9 shows the position and orientation of the ELLA-W1 modules as they are delivered on tape. The dimensions of the tapes are specified in Figure 10.

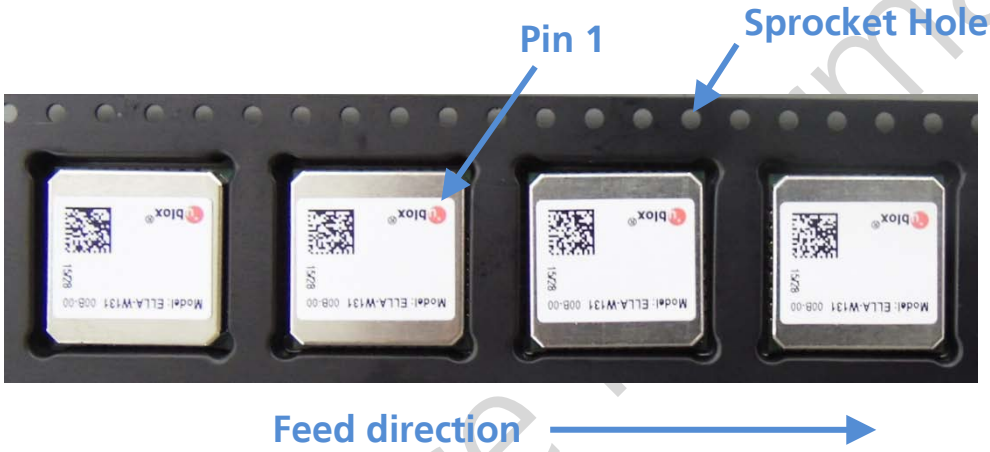

Figure 9: Orientation for ELLA-W1 modules on tape

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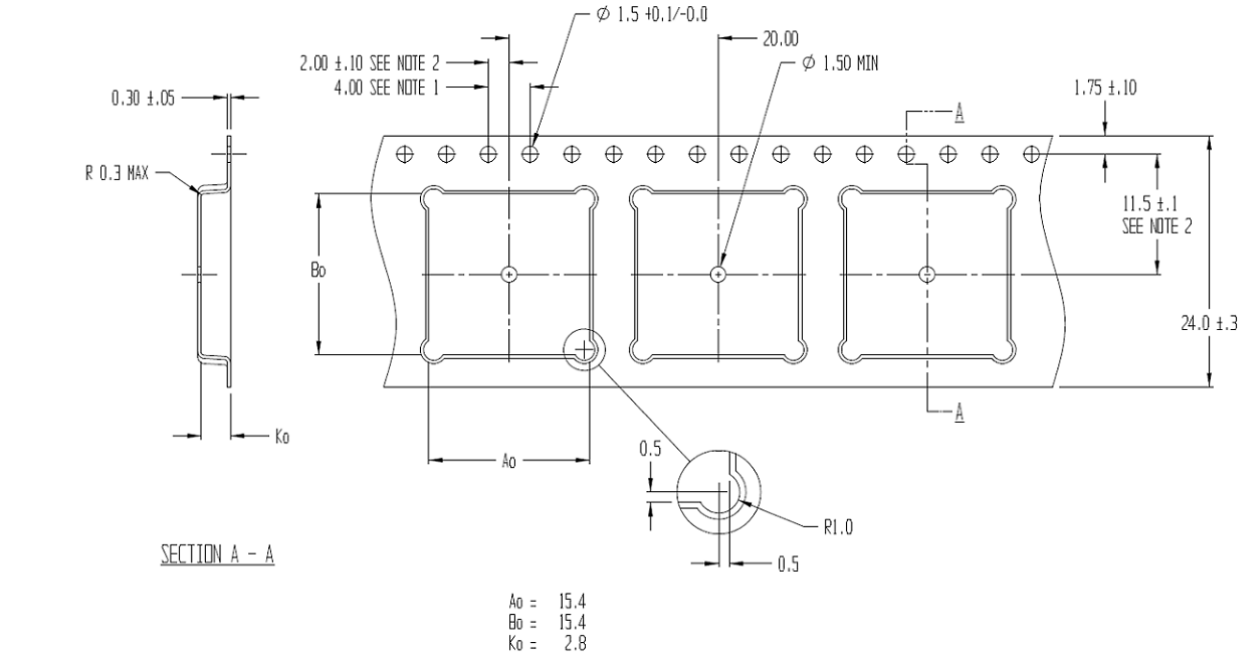

Figure 10: ELLA-W1 Tape dimensions

7.2 Shipment, storage and handling

For more information regarding shipment, storage and handling see the *u-blox Package Information Guide [1]*.

7.2.1 Moisture sensitivity levels

The modules are rated at moisture sensitivity level 3. See moisture sensitive warning label on each shipping bag for detailed information. After opening the dry pack, the modules must be mounted within 168 hours in factory conditions of maximum 30°C/60%RH or must be stored at less than 10%RH. The modules require baking if the humidity indicator card shows more than 10% when read at 23±5°C or if the conditions mentioned above are not met. Refer to J-STD-033B standard for bake procedure.

7.3 Reflow soldering

Reflow profiles are to be selected according to u-blox recommendations in the *ELLA-W1 System Integration Manual* [2].

Failure to observe these recommendations can result in severe damage to the device!

7.4 ESD handling precautions

ELLA-W1 series modules are Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the module!

ELLA-W1 series modules are Electrostatic Sensitive Devices (ESD) and require special ESD precautions typically applied to ESD sensitive components. See the *ELLA-W1 System Integration Manual* [2].

Failure to observe these recommendations can result in severe damage to the device!

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8 Labeling and ordering information

8.1 Product labeling

The labels of ELLA-W1 series include important product information as described in this section. The data matrix code for automotive and professional grade variants of ELLA-W1 series includes a serial number.

Figure 11 illustrates the label of automotive grade variant of ELLA-W1 series and includes: the u-blox logo, product name, type number, and data matrix code.

Figure 11: ELLA-W1 series – Automotive grade sample label

Figure 12 illustrates the label of professional grade variant of ELLA-W1 series and includes: the u-blox logo, product name (model), type number, FCC and IC certification numbers and date of unit production encoded YY/WW (year/week).

Figure 12: ELLA-W1 series – Professional grade sample label

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8.2 Explanation of codes

Three different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all u-blox products, independent of packaging and quality grade. The **Ordering Code** includes options and quality, while the **Type Number** includes the hardware and firmware versions. Table 23 below details these three different formats:

Format	Structure
Product Name	PPPP-TGVV
Ordering Code	PPPP-TGVV-TTQ
Type Number	PPPP-TGVV-TTQ-XX

Table 23: Product Code Formats

Table 24 explains the parts of the product code.

Code	Meaning	Example
PPPP	Form factor	ELLA
TG	Platform T – Dominant technology, For example, W: Wi-Fi, B: Bluetooth G - Generation	W1
VV	Variant based on the same platform; range [00…99]	31
TT	Major Product Version	00
Q	Quality grade A: Automotive B: Professional C: Standard	A
XX	Minor product version (not relevant for certification)	00

Table 24: Part identification code

8.3 Ordering codes

Ordering Code	Product name	Product
ELLA-W131-00B	ELLA-W131	ELLA-W131 professional grade module
ELLA-W131-00A	ELLA-W131-A	ELLA-W131 automotive grade module
ELLA-W133-00B	ELLA-W133	ELLA-W133 professional grade module
ELLA-W133-00A	ELLA-W133-A	ELLA-W133 automotive grade module
ELLA-W161-00B	ELLA-W161	ELLA-W161 professional grade module
ELLA-W161-00A	ELLA-W161-A	ELLA-W161 automotive grade module
ELLA-W163-00B	ELLA-W163	ELLA-W163 professional grade module
ELLA-W163-00A	ELLA-W163-A	ELLA-W163 automotive grade module
EVK-ELLA-W161-A	EVK-ELLA-W161	Evaluation kit for versions with 1 antenna pin (ELLA-W131, ELLA-W131-A, ELLA-W161 and ELLA-W161-A modules)
EVK-ELLA-W163-A	EVK-ELLA-W163	Evaluation kit for versions with 2 antenna pins (ELLA-W133, ELLA-W133-A, ELLA-W163 and ELLA-W163-A modules)

Table 25: Product ordering codes

☞ Product changes affecting form, fit or function are documented by u-blox. For a list of Product Change Notifications (PCNs) see our website. The IMDS number for ELLA-W1 series is 355902511.

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Appendix

A Glossary

Name	Definition
AES	Advanced Encryption Standard
AP	Access Point
BCA	Bluetooth Coexistence Arbiter
BDR	Basic Data Rate
BPF	Band-Pass Filter
CCMP	Counter-mode Cipher block chaining Message authentication code Protocol
CMAC	Cipher-based Message Authentication Code
dBm	Decibel-milliwatts
EDR	Enhanced Data Rate
EEPROM	Electrically Erasable Programmable Read-Only Memory
ESD	Electrostatic Sensitive Devices
GFSK	Gaussian Frequency Shift Keying
HS	High Speed
IMDS	International Material Data System
IMEI	International Mobile Equipment Identity
LED	Light-Emitting Diode
MAC	Medium Access Control
MSL	Moisture sensitivity level
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
PHY	Physical Layer
QD ID	Qualified Design ID
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RSS	Radio Standards Specification
SAR	Specific Absorption Rate
SDIO	Secure Digital Input Output
SIG	Special Interest Group
SISO	Single In, Single Out
SMD	Surface-Mount Device
TKIP	Temporal Key Integrity Protocol
VIO	Input Offset Voltage
WAPI	WLAN Authentication and Privacy Infrastructure
WEP	Wired Equivalent Privacy
WLAN	Wireless Local Area Network

Table 26: Explanation of abbreviations and terms used

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Related documents

[1] u-blox Package Information Guide, document number UBX-14001652

[2] ELLA-W1 System Integration Manual, document number UBX-15017046

☞ For regular updates to u-blox documentation and to receive product change notifications please register on our homepage.

Advance Information

Revision history

This document was previously the WiBear11n datasheet (provided by lesswire) for the revisions from 20-Jun-2012 until 10-Oct-2014.

Revision	Date	Name	Status / Comments
1.00	20-Jun-2012	ishe	Preliminary release
1.01	22-Jun-2012	ishe, avar, abei	Some minor mistakes fixed
1.02	16-Jul-2012	ishe	PCM interface description added. Supported channels presented in region independent form.
1.03	1-Oct-2012	ishe	Minor mistakes fixed. Evaluation Kit information added
1.04	5-Dec-2012	ddie	Updated order codes for latest hardware revision C
1.05	11-Jan-2013	ddie	Added installation and regulatory information
1.06	16-Jan-2013	ddie	Added label information and table with FCC/IC IDs
1.07	18-Jan-2013	ishe	Added Wi-Fi Direct mode support
1.08	18-Jan-2013	ishe	Requirements (Note 2) for Sleep Mode updated
1.09	22-Jan-2013	ddie	Added paragraph on IC compliance
1.10	6-Feb-2013	ddie	Added paragraph on IC compliance in French language
1.11	22-Feb-2013	lshe	Dimension drawing improved (tolerances added)
1.12	25-Feb-2013	ddie	FCC ID's and IC ID's with cross-reference to model numbers
1.13	28-Mar-2013	ddie	Added: RoHS compliance; mounting process (warpage); custom tariff numbers; IMDS number
1.14	7-May-2013	ddie	Electrical specification updated: minimum supply voltage and ripple noise, digital pad ratings corrected. Physical dimensions: Contour tolerances in corners of the PCB added.
1.15	14-May-2013	ddie	Added order information for tape & reel packing
1.16	15-May-2013	ddie	Corrected ordering information for variants DF1 and SF2 (T&R)
1.17	21-May-2013	ddie	Release, no changes.
1.18	19-Dec-2013	ddie	Approved antenna list extended
1.19	13-Mar-2014	ddie	Bluetooth QDID added, corrected several typos on page 3
1.20	10-Oct-2014	ddie	Approved antenna list extended
R01	3-Jun-2015	lalb, kfra, shoe	Document converted from lesswire WiBear 11n datasheet to u-blox ELLA-W1 datasheet and product name changed from WiBear 11n series to ELLA-W1 series. Professional grade variants added. FCC and IC ID's changed. Label contents changed. Delivery/shipment package and labels changed. Erroneous 2.6V for VIO Absolute Max Ratings removed.
R02	17-Jul-2015	lalb, mzes, kgom	Removed ANT-2.4-CW-RH and GW26.0151 from list of approved antennas. Added list of ELLA-W1 variants for each approved antenna. Added label specification for professional grade variant. Added notes that the approvals are pending. Changed reel type from reel type B to reel type A. Minor change in section 1.6. Updated the content in sections 4.4, 4.7.1, 6.1, 7.1.2, 7.2, and 7.3. Modified tables 2, 4, 8, and 22. Added sections 4.5 and 4.6. Included Figure 10.

Advance Information

Revision	Date	Name	Status / Comments
R03	16-Oct-2015	lalb, ovik	Moved sections *Reflow Soldering* and *ESD handling precautions* to the *ELLA-W1 System Integration Manual* [2]. Moved SDIO timing information to the *ELLA-W1 System Integration Manual* [2]. Added revision history from the time before u-blox acquired the WiBear 11n product series from lesswire. Removed support for channel 14. Removed "Pending approvals" notification in section 1.1 and section 6.1.2. Added note stating IEEE 802.11k/r is not supported by the Marvell software in section 1.6 – Supported features. Modified the FCC and IC IDs for all the models in Table 21. Modified Figure 11 - Professional grade sample label to reflect the new FCC and IC ids. Modified the content in subsections 6.1.1, 6.1.2 and 6.1.3.

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